

**MODEL REKA BENTUK KONSEPTUAL OPERASIAN STORAN DATA
BAGI APLIKASI KEPINTARAN PERNIAGAAN**

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PERAKUAN KERJA TESIS / DISERTASI

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Abstrak

Pembangunan aplikasi kepintaran perniagaan (BI) yang merangkumi sumber data, Gudang Data (DW), *Data Mart (DM)* dan Operasian Storan Data (ODS) memberi cabaran yang besar kepada pembangun aplikasi BI. Hal ini disebabkan oleh kekurangan model, garis panduan dan teknik yang mantap untuk membangunkan aplikasi BI jika dibandingkan dengan pembangunan sistem dalam disiplin kejuruteraan perisian. Tambahan pula, pembangunan aplikasi BI masa kini menumpukan kepada pembangunan maklumat strategik berbanding maklumat operasi dan taktikal. Oleh itu, tujuan utama kajian ini ialah untuk mengusulkan model reka bentuk konseptual ODS (CoDMODS) bagi pembangunan aplikasi BI. Melalui kaedah pengesahan pakar, model CoDMODS yang dibina dengan pendekatan penyelidikan sains reka bentuk ini dapat memenuhi sembilan ukuran dimensi kualiti model iaitu mudah difahami, meliputi langkah yang jelas, relevan, mempunyai ciri-ciri fleksibiliti, skalabiliti, ketepatan, kesempurnaan, konsisten dan menyokong jangka masa pengemaskinian. Selain itu, dua prototaip yang dibina berdasarkan model CoDMODS untuk kajian kes perkhidmatan bekalan air (iUBIS) dan penyelenggaraan telekomunikasi (iPMS) mencatatkan nilai purata min kepenggunaan yang tinggi iaitu 5.912 melalui instrumen *Computer System Usability Questionnaire (CSUQ)*. Dapatan kajian ini terutamanya model yang diusulkan, menyumbang kepada kaedah analisis dan reka bentuk pembangunan maklumat operasi dan taktikal aplikasi BI. Model ini boleh dijadikan garis panduan oleh pembangun aplikasi BI. Selain itu, prototaip yang dibangunkan dalam dua kajian kes dapat membantu pengurusan organisasi menggunakan maklumat yang berkualiti dalam operasi perniagaan.

Kata Kunci: Kepintaran Perniagaan, Operasian Storan Data, Model reka bentuk konseptual, Maklumat Operasi, Maklumat Taktikal.

Abstract

The development of business intelligence (BI) applications, involving of data sources, Data Warehouse (DW), Data Mart (DM) and Operational Data Store (ODS), imposes a major challenge to BI developers. This is mainly due to the lack of established models, guidelines and techniques in the development process as compared to system development in the discipline of software engineering. Furthermore, the present BI applications emphasize on the development of strategic information in contrast to operational and tactical. Therefore, the main aim of this study is to propose a conceptual design model for BI applications using ODS (CoDMODS). Through expert validation, the proposed conceptual design model that was developed by means of design science research approach, was found to satisfy nine quality model dimensions, which are, easy to understand, covers clear steps, is relevant and timeless, demonstrates flexibility, scalability, accuracy, completeness and consistency. Additionally, the two prototypes that were developed based on CoDMODS for water supply service (iUBIS) and telecommunication maintenance (iPMS) recorded a high usability average min value of 5.912 using Computer System Usability Questionnaire (CSUQ) instrument. The outcomes of this study, particularly the proposed model, contribute to the analysis and design method for the development of the operational and tactical information in BI applications. The model can be referred as guidelines by BI developers. Furthermore, the prototypes that were developed in the case studies can assist the organizations in using quality information for business operations.

Keywords: Business Intelligence, Operational Data Store, Conceptual design model, Operational Information, Tactical Information.

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Senarai Kependekan

BI	Kepintaran Perniagaan (<i>Business Intelligence</i>)
BIDS	<i>Business Intelligence Development Studio</i>
CIF	<i>Corporate Information Factory</i>
CEDI	Institut Pembangunan Koperasi Dan Keusahawanan(<i>Co-operative and Entrepreneur Development Institute</i>)
CIM	<i>Computation Independent Model</i>
CLDS	<i>Data Warehouse Development Life Cycle – Reverse from SDLC</i>
CoDMODS	Model Reka Bentuk Konseptual Operasian Storan Data (<i>Conceptual Design Model Operational Data Store</i>)
CSUQ	<i>Computer System Usability Questionnnnaire</i>
DM	<i>Data Mart</i>
DSS	Sistem Sokongan Keputusan (<i>Decision Support System</i>)
DW	Gudang Data (<i>Data Warehouse</i>)
DWARF	<i>Data Warehouse Requirement Definition Technique</i>
DWRM	<i>Data Warehouse Requirement Management</i>
EERM	Model Hubungan Entiti Teperluas (<i>Enhanced Entity Relationship Model</i>)
ERM	Model Hubungan Entiti (<i>Entity Relationship Model</i>)
ERP	<i>Enterprise Resource Planning</i>
ETL	<i>Extract-Transform-Load</i>
GST	Teori Sistem Umum (<i>General System Theory</i>)
INFOQUAL	Kualiti Maklumat (<i>Information Quality</i>)
INTERQUAL	Kualiti Antara Muka (<i>Interface Quality</i>)
iPMS	<i>intelligent Preventive Maintenance System</i>
IPTA	Institusi Pengajian Tinggi Awam
IT	Teknologi Maklumat (<i>Information Technology</i>)
iUBIS	<i>intelligent Utility Billing Information System</i>
JAD	<i>Joint Application Development</i>
JKR	Jabatan Kerja Raya
KBT	Teori Berasaskan Pengetahuan (<i>Knowledge Based Theory</i>)
MIS	Sistem Maklumat Pengurusan (<i>Management Information System</i>)
NRW	Air Tidak Berhasil (<i>Non Revenue Water</i>)
ODS	Operasian Storan Data (<i>Operational Data Store</i>)
OIPT	Teori Pemprosesan Maklumat Dalam Organisasi (<i>Organization Information Theory Processing</i>)
OLAP	<i>Online Analytical Processing</i>
OLTP	<i>Online Transaction Processing</i>
PIM	<i>Platform Independent Model</i>
PSM	<i>Platform Specific Model</i>
SADA	Syarikat Air Darul Aman
SDLC	Kitar Hayat Pembangunan Sistem (<i>Software Development Life Cycle</i>)
SK	<i>Surrogate Key</i>
SOM	<i>Semantic Object Model</i>

SPAN	Suruhanjaya Perbadanan Air Negara
SSAS	<i>SQL Server Analysis Service</i>
SSIS	<i>SQL Server Integration Service</i>
SSRS	<i>SQL Server Report Service</i>
SYABAS	Syarikat Bekalan Air Selangor
SYSUSE	<i>System Usefulness</i>
SQL	<i>Structured Query Language</i>
UBIS	<i>Utility Billing Information System</i>

CHAPTER ONE

Pengenalan

1.1 Latar Belakang

Persekitaran perniagaan masa kini memerlukan maklumat yang berkualiti untuk menilai pencapaian organisasi, memahami kehendak pelanggan, mengetahui kemampuan pesaing dan membuat keputusan dalam organisasi. Penggunaan teknologi maklumat dilihat sebagai teknologi yang dapat memproses maklumat secara sistematik dalam organisasi. Kelebihan penggunaan teknologi maklumat dalam pengurusan maklumat secara langsung akan mendorong organisasi membangunkan pelbagai sistem aplikasi untuk menyokong operasi sesebuah perniagaan. Justeru, semakin banyak sistem aplikasi dibangunkan akan menyebabkan organisasi terpaksa mengurus data yang banyak dan berlakunya limpahan maklumat dalam organisasi. Tambahan pula, data yang diproses dalam sistem aplikasi masa kini terdiri daripadapelbagai peringkat, data dari aplikasi yang berbeza dan data ditempatkan di lokasi yang berbeza(Luo, 2012; Mohanty, 2006). Rainer, Turban, Sharda dan Delen (2011)menambah, keadaan ini akan menyebabkan pengurusan data bertambah sukar dan menimbulkan masalah bagi mendapatkan maklumat yang tepat untuk membuat keputusan dalam organisasi.

Kepintaran Perniagaan (*Business Intelligence-BI*) dan Gudang Data (*Data Warehouse-DW*) merupakan dua pendekatan teknologi yang sedang berkembang maju dalam bidang teknologi maklumat untuk menyelesaikan masalah ini. Menurut ramalan yang dibuat Gartner, pasaran BI berkembang sebanyak 9.7% iaitu meningkat ke angka 0.8 billion USD pada tahun 2011 (Gartner, 2011). Perisian BI juga diletakkan sebagai 5 keutamaan teratas bagi teknologi yang digunakan oleh

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- Adelman, S., Bischoff, J., Dyche, J., Hackney, D., Ivoghli, S., Kelley, C., . . . Rehm, C. (2003). *Impossible Data Warehouse Situations: Solutions from the Experts*: Addison-Wesley.
- Alavi, M., & Leidner, D. E. (2001). Review: Knowledge Management and Knowledge Management Systems. *MIS Quarterly*, 25(1), 107-136.
- Alshawih, S., Missi, F., & Irani, Z. (2011). Organisational, technical and data quality factors in CRM adoption — SMEs perspective. *Industrial Marketing Management*, 40(3), 376-383. doi: 10.1016/j.indmarman.2010.08.006
- Anahory, S., & Muray, D. (1997). *Data Warehousing in the Real World: A Practical Guide for Building Decision Support Systems*. Boston, MA, USA: Addison-Wesley Longman Publishing Co., Inc.
- Anavi-Chaput, V., Bossman, P., Catterall, R., Hansson, K., Hicks, V., Kumar, R., & Son, J. (2000). *Business Intelligence Architecture on S/390 Presentation Guide* (First ed.): IBM Corporation.
- Ariyachandra, T., & Watson, H. (2010). Key organizational factors in data warehouse architecture selection. *Decision Support Systems*, 49(2), 200-212. doi: 10.1016/j.dss.2010.02.006
- Ballard, C., Farrell, D. M., Gupta, A., Mazuela, C., & Vohnik, S. (2006). *Dimensional Modeling: In a Business Intelligence Environment*: IBM Corporation.
- Ballou, D. P., & Pazer, H. L. (2003). Modeling Completeness Versus Consistency Tradeoffs In Information Decision Systems. *IEEE Transactions On Knowledge And Data Engineering*, 15(1), 240-243.
- Baragoin, C., Marini, M., Morgan, C., Mueller, O., Perkins, A., & Yim, K. H. (2001). *Building the Operational Data Store on DB2 UDB Using IBM Data Replication, WebSphere MQ Family, and DB2 Warehouse Manager*. San Jose, California: IBM Corporation.
- Barney, J. (1991). Firm Resources and Sustained Competitive Advantages. *Journal of Management*, 17, 99-120.
- Batini, C., Cappiello, C., Francalanci, C., & Maurino, A. (2007). Methodologies for Data Quality Assessment and Improvement. *ACM Computing Surveys*, Vol. 41, No. 3 (Article 16).
- Beck, L. C., Trombetta, W. L., & Share, S. (1986). Using focus group session before decisions are made. *North California Medical Journal*, 47(2), 73-74.
- Bennett, S., McRobb, S., & Farmer, R. (2002). *Object-Oriented System Analysis And Design Using UML* (2nd ed.): McGraw-Hill Companies.
- Bento, A., & Bento, R. (2006). Factors Affecting the Outcomes of Performance Management Systems. *Journal of Information Technology Management*, XVIII(Number 2), 23-32.
- Bertalanffy, L. v. (1969). *General System Theory: Foundations, Developments, Applications*. New York: George Braziller.
- Bertossi, L., Rizzolo, F., & Jiang, L. (2011). Data Quality Is Context Dependent Enabling Real-Time Business Intelligence. In M. Castellanos, U. Dayal & V. Markl (Eds.), (Vol. 84, pp. 52-67): Springer Berlin Heidelberg.
- Bischoff, J., & Alexander, T. (1997). Introduction to Data Warehousing *Data Warehouse: Practical Advice from the Experts* (1st ed., pp. 11). Upper Saddle River, New Jersey: Prentice Hall Publisher.
- Boehm, B. (1999). B. Boehm. Software Risk Management. *IEEE Computer Society Press*.

- Boehnlein, M., & Ende, A. U.-v. (1999). Deriving Initial Data Warehouse Structures from the Conceptual Data Models of the Underlying Operational Information Systems.
- Boehnlein, M., & Ende, A. U.-v. (2000). Business Process Oriented Development of Data Warehouse Structures. *Datawarehousing 2000*.
- Bonifati, A., Cattaneo, F., Ceri, S., Fuggetta, A., & Paraboschi, S. (2001). Designing data marts for data warehouses. *ACM Trans. Softw. Eng. Methodology*, 10(4), 452-483.
- Bovee, M., Srivastava, R. P., & Mak, B. (2003). A Conceptual Framework and Belief-Function Approach to Assessing Overall Information Quality. *International Journal of Intelligent Systems*, Volume 18, No. 1, January 2003, pp. 51-74., 18(1), 51-74.
- Brackett, M. H. (1996). *The Data Warehouse Challenge*. Canada: Katherine Schowalter.
- Bruckner, R. M., List, B., & Schiefer, J. (2001, 3-5 August). *Developing Requirements for Data Warehouse Systems with Use Cases*. Paper presented at the Seventh Americas Conference on Information Systems (AMCIS 2001), Boston, Massachusetts, USA.
- Chen, M. (1976). The entity-relationship model—toward a unified view of data. *ACM Transactions on Database Systems (TODS)*, 1(1), 9-36.
- Cheng, B. H. C., & Atlee, J. M. (2007). *Research Direction in Requirements Engineering*. Paper presented at the Future of Software Engineering (FOSE'07).
- Chung, L. M. Y., Chung, J. W. Y., & Wong, T. K. S. (2009). Usability Test of an Interactive Dietary Recording. *International Electronic Journal of Health Education*, (12), 123-134.
- Codd, E. F. (1970). A Relational Model of Data for Large Shared Data Banks. *Communication of the ACM*, 13(6), 377-387.
- Codd, E. F. (1982). Relational Database: A Practical Foundation for Productivity. *Communications of the ACM*, 25(2), 109-117.
- Cody, W. F., Kreulen, J. T., Krishna, V., & Spangler, W. S. (2002). The integration of business intelligence and knowledge management. *IBM System Journal*, 41(4), 697-713.
- Connolly, T., & Begg, C. (2005). *Database Systems: A Practical Approach to Design, Implementation, and Management* (4th ed.): Addison-Wesley.
- Connolly, T., & Begg, C. (2010). *Database Systems: A Practical Approach to Design, Implementation, and Management* (5th ed.): Addison-Wesley.
- Cysneiros, L. M., Werneck, V., & Yu, E. (2005). Evaluating Methodologies: A Requirements Engineering Approach Through the Use of an Exemplar. *Journal of Computer Science & Technology*, Vol. 5 No. 2.
- d'Orazio, L., & Bimonte, S. (2010). Multidimensional Arrays for Warehousing Data on Clouds. In A. Hameurlain, F. Morvan & A. Tjoa (Eds.), *Data Management in Grid and Peer-to-Peer Systems* (Vol. 6265, pp. 26-37): Springer Berlin / Heidelberg.
- Dale, M. (2004, 6-7 December). *Defining User Requirements for a Large Corporate Data Warehouse: An Experiential Case Study*. Paper presented at the 9th Australian Workshop on Requirements Engineering (AWRE'04), Adelaide, Australia.
- Date, C. J. (2007). *An Introduction to Database Systems* (8th ed.): Addison Wesley.
- Davis, A. M. (1993). *Software Requirements: Objects, Functions and States* (2nd ed.): Prentice Hall.
- Dennis, A., & Wixom, B. H. (2003). *Systems Analysis Design* (2nd ed.): John Wiley & Sons, Inc.
- Eckerson, W. W. (2003). Smart Companies in the 21st Century: The Secrets of Creating Successful Business Intelligence Solutions: The Datawarehouse Institute (TDWI).
- Eckerson, W. W. (2007). Best Practice in Operational BI: Converging Analytical and Operational Processes. Chatsworth, CA.: TDWI.
- Erickson, A. (2005, 19-20 May). *Indsutries Drivers & Best Practice for Business Intelligence*. Paper presented at the EUCI's Business Intelligence for Utilities - 2nd Annual Conference, Chicago Illinios.

- Even, A., Shankaranarayanan, G., & Berger, P. D. (2010). Evaluating a model for cost-effective data quality management in a real-world CRM setting. *Decision Support Systems*, 50(1), 152-163. doi: 10.1016/j.dss.2010.07.011
- Firestone, J. M. (1998). Dimensional Modeling and E-R Modeling In The Data Warehouse, from file:///E:/FrontPage Webs/Content/EISWEB/DMERDW.html
- Freudi, M., & Salinesi, C. (2003). *Requirements Engineering for Data Warehousing*. Paper presented at the 9th International Workshop on Requirements Engineering : Foundations of Software Quality(REFSQ'03).
- Galbraith, J. R. (1973). *Designing Complex Organizations*: Addison-Wesley, Reading, MA.
- Gartner. (2011). Gartner Forecasts Global Business Intelligence Market to Grow 9.7 Percent in 2011 Retrieved 10 Mac 2011, 2011, from <http://www.gartner.com/it/page.jsp?id=1553215>
- Gattiker, T. F., & Goodhue, D. L. (2004). Understanding the local-level costs and benefits of ERP through organizational information processing theory. *Information and Management*, 41(4), 431 - 443.
- Gatzu, S., & Vavouras, A. (1999). Data Warehousing: Concepts and Mechanisms. *INFORMATIK*, 1(1999).
- Geiger, J. G. (2011). How to Validate the Data Model Retrieved 1 July 2011, 2011, from http://www.information-management.com/issues/21_2/
- Gibson, M., Arnott, D., & Jagielska, I. (2004, 1 to 3 July). *Evaluating the Intangible Benefits of Business Intelligence: Review & Research Agenda*. Paper presented at the Proceedings of the 2004 IFIP International Conference on Decision Support Systems (DSS2004): Decision Support in an Uncertain and Complex World, Prato, Italy.
- Giorgini, P., Rizzi, S., & Garzetti, M. (2005, 4–5 November). *Goal-Oriented Requirement Analysis for Data Warehouse Design*. Paper presented at the ACM Eighth International Workshop on Data Warehousing and OLAP (DOLAP'05), Bremen, Germany.
- Giorgini, P., Rizzi, S., & Garzetti, M. (2008). GRAnD: A Goal-Oriented Approach to Requirement Analysis in Data Warehouses. *Decision Support Systems*, 45(1), 4-21.
- Golfarelli, M. (2010). From User Requirements to Conceptual Design in Data Warehouse Design - a Survey. *Data Warehouse Design and Advanced Engineering Applications: Methods for Complex Construction*, 1-16.
- Golfarelli, M., Maio, D., & Rizzi, S. (1998). *Conceptual Design of Data Warehouses from E/R Schemes*. Paper presented at the 31st HICSS.
- Golfarelli, M., Rizzi, S., & Turricchia, E. (2011). Modern Software Engineering Methodologies Meet Data Warehouse Design: 4WD. In A. Cuzzocrea, Dayal, Umeshwar (Ed.), *Data Warehousing and Knowledge Discovery* (Vol. 6862, pp. 66-79): Springer Berlin / Heidelberg.
- Gonzales, M. L. (2003). *IBM Data Warehousing*. Indiana, USA: Wiley Publishing, Inc.
- Gorry, G. A., & Scot-Morten, M. S. (1971). A framework for management information systems. *Sloan Management Review*, 13(1), 55-70.
- Grant, R. M. (1996). Toward A Knowledge-Based Theory of The Firm. *Strategic Management Journal*, 17(Winter Special Issue), 109-122.
- Guo, Y., Tang, S., Tong, Y., & Yang, D. (2006, 10 November). *Triple-driven data modeling methodology in data warehousing: a case study*. Paper presented at the DOLAP '06: 9th ACM international workshop on Data warehousing and OLAP, Arlington, Virginia, USA.
- Gustafson, D. A. (2002). *Software Engineering: Theory and Problems of Software Engineering*: McGraw-Hill Professional.
- Han, J., & Kamber, M. (2006). *Data Mining: Concepts and Techniques* (2nd ed.). USA: Elsevier Science & Technology Book.

- Harris, P. A., Swafford, J. A., Edwards, T. L., Zhang, M., Nigavekar, S. S., Yarbrough, T. R., . . . Pulley, J. M. (2011). StarBRITE: The Vanderbilt University Biomedical Research Integration, Translation and Education portal. *Journal of Biomedical Informatics*, 44(4), 655-662. doi: 10.1016/j.jbi.2011.01.014
- Heary, C. M., & Hennessy, E. (2000). The Use of Focus Group Interviews in Pediatric Health Care Research. *Journal of Pediatric Psychology*, 27(1), 47-57.
- Helfert, M. (2001, July 2001). *Managing and Measuring Data Quality in Data Warehousing*. Paper presented at the World Multiconference on Systemics, Cybernetics and Informatics, Orlando, USA.
- Hemingway, T., Lee, L., & Murdoch, L. (2005). *The Next Generation of the Data Warehouse at UNISA*. Paper presented at the Educause 2005.
- Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design Science in Information Systems Research. *MIS Quarterly*, 28(1), 75-105.
- Heylighen, F., & Joslyn, C. (1992). What is Systems Theory? Retrieved 15 February, 2007, from <http://pespmc1.vub.ac.be/SYSTHEOR.html>.
- Hwang, M. I., & Xu, H. (2007). The Effect of Implementation Factors on Data Warehousing Success: An Exploratory Study. *Journal of Information, Information Technology, and Organizations, Volume 2*.
- IEEE. (2004). Guide to the Software Engineering Body of Knowledge (Swebok). Los Alamitos, California: IEEE Computer Society.
- Imhoff, C. (2002). Crystal Clear Customer: The Role of the Operational Data Store Retrieved 20 January, 2007, from http://www.intelsols.com/documents/Imhoff_10-02.pdf
- Imhoff, C., Gallemmo, N., & Geiger, J. G. (2003). *Mastering Data Warehouse Design: Relational and Dimensional Techniques*. Indianapolis, Indiana: Wiley Publishing, Inc.,.
- Inmon, W. H. (1993). *Building the Data Warehouse*: John Wiley & Sons, Inc.
- Inmon, W. H. (1995, February 1995). The Operational Data Store. *InfoDB, Feb 1995*.
- Inmon, W. H. (1998, July 1998). The Operational Data Store: Designing the Operational Data Store. *Information Management Magazine, July 1998*.
- Inmon, W. H. (1999). *Building the Operational Data Store* (2nd ed.): John Wiley & Sons, Inc.
- Inmon, W. H. (2000, January 2000). ODS Types. *DM Review Magazine*.
- Inmon, W. H. (2002). *Building the Data Warehouse* (3rd ed.). Indianapolis, Indiana: John Wiley & Sons, Inc.,.
- Inmon, W. H. (2005). *Building the Data Warehouse* (4th ed.). Indianapolis, Indiana, USA: Wiley Publishing, Inc.
- Jarke, M., List, T., & Kolle, J. (2000, 10-14 September). *The Challenge of Process Data Warehousing*. Paper presented at the 26th International Conference on Very Large Data Bases, Cairo, Egypt.
- Jarke, M., & Vassiliou, Y. (1997). *Data Warehouse Quality: A Review of the DWQ Project*. Paper presented at the 2nd Conference on Information Quality, Massachusetts Institute of Technology, Cambridge.
- Kemper, H.-G., & Lee, P.-L. (2002, 6-9 January). *The customer-centric data warehouse - an architectural approach to meet the challenges of customer orientation*. Paper presented at the 36th Annual Hawaii International Conference on System Science (HICSS'03), Hawaii, USA.
- Khosrowpour, M. (2004). *Advanced Topics in Information Resources Management*: Idea Group Inc (IGI).
- Kimball, R. (1996). *The Data Warehouse Toolkit: Practical Techniques for Building Dimensional Data Warehouses*: John Wiley & Sons, Inc.

- Kimball, R. (1997, 3 November 1997). Relocating the ODS: Moving the Operational Data Store will solve a number of problems Retrieved 12 September, 2007, from <http://www.dbmsmag.com/9712d05.html>
- Kimball, R., & Caserta, J. (2004). *The Data Warehouse ETL Toolkit. Practical Techniques for Extracting, Cleaning, Conforming, and Delivering Data*. Indianapolis, USA: John Wiley.
- Kimball, R., & Ross, M. (2002). *The Data Warehouse Toolkit: The Complete Guide to Dimensional Modeling* (2nd ed.): John Wiley & Sons, Inc.
- Kirk, J. (2006). Gartner forecasts growing BI market: Survey shows BI ranks as CIOs' highest technology priority Retrieved 20 March, 2007, from http://www.infoworld.com/archives/emailPrint.jsp?R=printThis&A=/article/06/02/07/75128_HNbimarket_1.html
- Kontio, J., Lehtola, L., & Bragge, J. (2004). *Using the Focus Group Method in Software Engineering: Obtaining Practitioner and User Experiences*. Paper presented at the International Symposium on Empirical Software Engineering, Redondo Beach, CA.
- Krueger, R. A. (1994). *A practice guide for applied research*. Thousand Oak, California: Sage Publication, Inc.
- Kurtyka, J. (2005). A Systems Theory of Business Intelligence Retrieved 24 April, 2007, from <http://www.dmreview.com/issues/20051201/1042317-1.html>
- Ladley, J. (1997). Operational Data Stores: Developing an effective strategy. In J. Bischoff & T. Alexander (Eds.), *Data warehouse: practical advice from the experts* (pp. 296-308). Upper Saddle River, NJ, USA: Prentice-Hall, Inc.
- Lamsweerde, A. V. (2010). *Requirements Engineering from System Goal to UML to Software Specifications* (First ed.). West Sussex, England: John Wiley & Sons.
- Lewis, J. R. (1993). IBM Computer Usability Satisfaction Questionnaires: Psychometric Evaluation and Instructions for Use. Boca Raton, Florida: International Business Machines Corporation (IBM).
- Lewis, J. R. (1995). IBM Computer Usability Satisfaction Questionnaires: Psychometric Evaluation and Instructions for Use. *International Journal of Human-Computer Interaction*, v.7 n.1, p.57-78.
- Lewis, J. R. (2001). Psychometric Evaluation of the CSUQ Using Data from Five Years of Usability Studies. West Palm Beach, Florida: IBM Voice Systems.
- Lieberman, B. A. (2007, 17 April 2007). Applying an analytical framework: Organize and reuse valuable techniques, tools, and examples Retrieved 11 November, 2007
- List, B., Bruckner, R. M., Machaczek, K., & Schiefer, J. (2002). A Comparison of Data Warehouse Development Methodologies: Case Study of the Process Warehouse. *DEXA*, 203-215.
- List, B., Schiefer, J., & Tjoa, A. M. (1999). Process-Oriented Requirement Analysis Supporting the Data warehouse Design Process: A Use Case Driven Approach. *DEXA LNCS, Vol. 1873*, 593-603.
- Liu, X., & Xu, X. (2011). Requirement Analysis for Data Warehouse Based on Tropos [CORD Conference Proceeding]. *CORD Conference Proceeding*, 1-5 DO - 10.1109/ISA.2011.5873246.
- Luo, S. L. a. C. H. a. S. W. a. Q. (2012). Data Warehouse Design For Earth Observation Satellites. *Procedia Engineering*, 29(0), 3876-3882.
- Maciaszek, L., Liong, B. L., & Bills, S. (2005). *Practical Software Engineering: A Case Study Approach*: Addison-Wesley.
- Malinowski, E., & Zimanyi, E. (2006). *Requirement Specification and Conceptual Modeling for Spatial Data Warehouse*. Paper presented at the 22th British National on Advances in GIS.
- Mannino, M. V. (2007). *Database Design, Application Development, & Administration* (3rd ed.). New York: McGraw-Hill Companies, Inc.

- March, S. T., & Smith, G. F. (1995). Design and natural science research on information technology. *Decision Support Systems*, 15, 251-266.
- Marco, D. (2001). Top 10 Mistakes to Avoid When Developing a Metadata Repository Retrieved 20 April, 2007, from <http://www.tdan.com/view-articles/4926>
- Martinez, E. F., Chen, S. Y., & Liu, X. (2009). Evaluation of a Personalized Digital Library based on Cognitive Styles: Adaptivity vs. Adaptability. *International Journal of Information Management*, 29(1), 48-56.
- Mazon, J.-N., & Trujillo, J. (2007). A Model-Driven Goal-Oriented Requirement Approach for Data warehouse. *Springer-Verlag Berlin Heidelberg*(LCNS 2802), 255-264.
- Meyer, D., & Cannon, C. (1998). *Building a Better Data Warehouse*. Paramus, NJ, USA: Prentice Hall PTR.
- Mohanty, S. (2006). *Data Warehousing Design, Development and Best Practices*: Tata McGraw-Hill Publishing Company Limited.
- Moody, D. L., & Kortink, M. A. R. (2000, 5-6 June). *From Enterprise Models to Dimensional Models: A Methodology for Data Warehouse and Data Mart Design*. Paper presented at the International Workshop on Design and Management of Data Warehouses (DMDW'2000), Stockholm, Sweden.
- Moody, D. L., & Kortink, M. A. R. (2007). From ER Models to Dimensional Models: Advanced Design Issues Retrieved 8 October, 2007, from <http://www.dw-institute.org/research/display.aspx?ID=6961>
- Morgan, D. L. (1998). *The focus group handbook*. Thousand Oak, CA: Sage.
- Mundy, J., Thornthwaite, W., & Kimball, R. (2006). *The Microsoft Data Warehouse Toolkit: With SQL Server 2005 and the Microsoft Business Intelligence Toolset*: John Wiley.
- Mundy, J., Thornthwaite, W., & Kimball, R. (2011). *The Microsoft Data Warehouse Toolkit: With SQL Server 2008 R2 and the Microsoft Business Intelligence Toolset* (2nd ed.): John Wiley.
- Naumann, F. (2002). *Quality-Driven Query Answering for Integrated Information Systems*: Springer.
- Negash, S., & Gray, P. (2003, 4-6 August). *Business Intelligence*. Paper presented at the Ninth Americas Conference on Information System (AMCIS 2003), Tampa, Florida.
- Neighbors, J. M. (1984). The Draco Approach to Constructing Software from Reusable Components. *IEEE Transactions of Software Engineering*, SE-10(5)(September 1984.).
- Nickerson, J. A., & Zenger, T. R. (2004). A Knowledge-Based Theory of the Firm—The Problem-Solving Perspective. *Organization Science*, 15(6), 617-632.
- Niedrite, L., Treimanis, M., Solodovnikova, D., & Grundmane, L. (2009). Development of data warehouse conceptual models: Method engineering approach, in Progressive Methods in Data Warehousing and Business Intelligence. In D. Taniar (Ed.), *Progressive Methods in Data Warehousing and Business Intelligence: Concepts and Competitive Analytics* (pp. 1-23).
- Nielsen, J. (1993). *Usability Engineering*. San Francisco, U.S.A: Morgan Kaufmann.
- Nielsen, J. (1997). The Use and Misuse of Focus Groups. *IEEE Software*, 14(1), 94-95.
- Olszak, C. M., & Ziemba, E. (2006). Business Intelligence Systems in the Holistic Infrastructure Development Supporting Decision-Making in Organisations. *Interdisciplinary Journal of Information, Knowledge, and Management (IJIKM)*, 1, 47-58.
- Paim, F. R. S., & Castro, J. F. B. (2003). *DWARF: An Approach for Requirements Definition and Management of Data Warehouse Systems*. Paper presented at the 11th IEEE International Requirements Engineering Conference (RE'03).
- Pearce, M. (1998). Get full value from focus-group research. *Ivey Business Journal*, 63(2), 72-77.

- Pipino, L. L., Lee, Y. W., & Wang, R. Y. (2002). Data Quality Assessment. *Communication of the ACM*, April 2002/Vol 45(No. 4ve), 211-218.
- Poe, V. (1996). *Building a Data Warehouse for Decision Support*. Upper Saddle River, NJ: Prentice Hall PTR.
- Ponniah, P. (2010). *Data Warehousing Fundamentals For IT Professionals* (Second ed.). New Jersey: John Wiley & Sons.
- Prakash, N., & Gosain, A. (2003, 16 - 20 June). *Requirements Driven Data Warehouse Development*. Paper presented at the The 15th Conference on Advanced Information Systems Engineering (CAiSE '03), Klagenfurt Velden, Austria.
- Prakash, N., Prakash, D., & Gupta, D. (2011). Decisions and Decision Requirements for Data Warehouse Systems. In P. Soffer & E. Proper (Eds.), *Information Systems Evolution* (Vol. 72, pp. 92-107): Springer Berlin Heidelberg.
- Pushpal, D., & Apurva, D. (2011). The Study on Data Warehouse Modelling and OLAP for Birth Registration System of the Surat City Technology Systems and Management. In K. Shah, V. R. Lakshmi Gorty & A. Phirke (Eds.), (Vol. 145, pp. 160-167): Springer Berlin Heidelberg.
- Puttangunta, N. (2006). Active Data Warehousing and the Quest for Real-Time BI Retrieved 20 August, 2007, from <http://www.dmreview.com/dmdirect/20061013/1065026-1.html>
- Rainer, R. K., Turban, E., & Potter, R. E. (2007). *Introduction to Information System : Supporting and Transforming Business*: John Wiley & Sons Inc.
- Rasmussen, N., Goldy, P. S., & Solli, P. O. (2002). *Financial Business Intelligence: Trends, Technology, Software Selection, and Implementation*: John Wiley & Sons, Inc.
- Ravn, T., & Hoedholt, M. (2009, May, 2009). How to Measure and Monitor the Quality of Master Data. *Information Management Magazine*.
- Redman, T. (1998). The Impact of Poor Data Quality on the Typical Enterprise. *Communication of the ACM*, 41(2), 79-82.
- Reingruber, M., & Gregory, W. W. (1994). *The Data Modeling Handbook: A Best-Practice Approach to Building Quality Data Models*: John Wiley & Sons, Inc.
- Reinschmidt, J., & Francoise, A. (2000). *Business Intelligence Certification Guide* (1st ed.): IBM Corporation, San Jose, Carlifornia.
- Rezabek, R. J. (2000). Online Focus Groups: Electronic Discussions for Research. *Qualitative Social Research On-line Journal*, Volume 1, No. 1.
- Rizzi, S., Abello, A., Lechtenborger, J., & Trujillo, J. (2006, 10 November). *Research in data warehouse modeling and design: dead or alive?* Paper presented at the DOLAP '06: Proceedings of the 9th ACM international workshop on Data warehousing and OLAP, Arlington, Virginia, USA.
- Rob, P., & Coronel, C. (2004). *Database System Design* (5th ed.): Thomson Learning EMEA, Ltd.
- Robinson, S. (2006). *Issue in conceptual modelling for simulation: Setting a research agenda*. Paper presented at the 2006 OR Society Simulation Workshop.
- Rome, J. (2002). Development of Data Warehouse Retrieved 11 July, 2007, from http://www.okairp.org/archive/F05_RomeNACUBOArticle.pdf
- Sahama, T. R., & Croll, P. R. (2007). *A Data Warehouse Architecture for Clinical Data Warehousing*. Paper presented at the ACSW '07: Proceedings of the fifth Australasian symposium on ACSW frontiers, Ballarat, Australia.
- Sarkar, A. (2012). Data Warehouse Requirements Analysis Framework: Business-Object Based Approach. *IJACSA International Journal of Advanced Computer Science and Applications*, Vol. 3(No. 1), 25-34.
- Schaffner, J., Bog, A., Krüger, J., & Zeier, A. (2009). A Hybrid Row-Column OLTP Database Architecture for Operational Reporting In M. Castellanos, U. Dayal & T.

- Sellis (Eds.), *Business Intelligence for the Real-Time Enterprise* (Vol. 27, pp. 61-74): Springer Berlin Heidelberg.
- Schiefer, J., List, B., & Bruckner, R. M. (2002, 9-11 August). *A holistic approach for managing requirements of data warehouse systems*. Paper presented at the Eighth Americas Conference on Information Systems (AMCIS), Dallas, Texas.
- Schmuller, J. (2002). *Sams Teach Yourself UML in 24 Hours*. Indianapolis, Indiana, USA: Sams Publishing.
- Schuelke, C. (2001, 20 August 2008). Best Practice Approaches to Operational, Tactical and Strategic Reporting, from Information Management
- Sen, A., & Sinha, A. P. (2005). A comparison of data warehousing methodologies. *Communications ACM*, 48(3), 79-84.
- Sen, A., & Sinha, A. P. (2007). Toward Developing Data Warehousing Process Standards: An Ontology-Based Review of Existing Methodologies. *IEEE Transactions on Systems, Man, and Cybernetic*, 37(1), 17 - 31.
- Shahbani, M., & Shiratuddin, N. (2011). Conceptual Design Model Using Operational Data Store (CoDMODS) for Developing Business Intelligence Applications. *International Journal of Computer Science and Network Security (IJCSNS)*, 11(2), 161-168.
- Shahzad, K., & Zdravkovic, J. (2011, May 19-21). *Towards Goal-driven Access to Process Warehouse: Integrating Goals with Process Warehouse for Business Process Analysis*. Paper presented at the Research Challenges in Information Science (RCIS), 2011 Fifth International Conference, Guadeloupe - French West Indies, France.
- Shanks, G., Tansley, E., & Weber, R. (2003). Using ontology to validate conceptual models. *Communications ACM*, 46(10), 85-89.
- Shiratuddin, N. (2005). E-Books in Higher Education: Technology, E-Marketing Process Pricing Strategy. *Journal of Electronic Commerce in Organizations*, 3(2), 1-16.
- Shmueli, G., Patel, N. R., & Bruce, P. C. (2010). *Data Mining for Business Intelligence*. New Jersey U.S.A: John Wiley & Sons.,
- Shneiderman, B., & Plaisant, C. (2005). *Designing the User Interface: Strategies for Effective Human-Computer Interaction* (4 th. ed.). California: Addison Wesley.
- Simon, A. R., & Shaffer, S. L. (2001). *Data Warehousing and Business Intelligence for e-Commerce* (1st ed.): Morgan Kaufmann Publisher.
- Sobreperez, P. (2008). Using Plenary Focus Groups in Information Systems Research: More than a Collection of Interviews. *The Electronic Journal of Business Research Methods*, 6(2), 181 - 188.,
- Sommerville, I. (2004). *Software Engineering* (7th ed.): Addison Wesley.
- Spil, T. A. M., Stegwee, R. A., & Teitink, C. J. A. (2002). *Business Intelligence in Healthcare Organizations*. Paper presented at the Proceedings of the 35th Hawaii International Conference on System Sciences (HICSS-35'02), Hawaii.
- Stake, R. E. (1995). *The Art of Case Study Research*. California, USA: Sage Publications, Inc.
- Stewart, D. W., & Shamdasani, P. N. (1990). *Focus groups: Theory and Practice*. Thousand Oak, CA: Sage.
- Stock, G. N., & Tatikonda, M. V. (2004). External technology integration in product and process development. *International Journal of Operations & Production Management (IJOPM)*, 4(7), 642-665.
- Sungard. (2007). *Operational Data Store Handbook* (Vol. 3.1). Malvern, Pennsylvania, USA: SunGard Higher Education.
- Sveiby, K.-E. (2001). A knowledge-based theory of the firm to guide in strategy formulation. *Journal of Intellectual Capital*, 2 (No. 4), 344-358.

- Tatikonda, M. V., & Rosenthal, S. R. (2000). Technology novelty, project complexity, and product development project execution success: A deeper look at task uncertainty in product innovation. *IEEE Transactions on Engineering Management*, 47(1), 74-87.
- Thakur, G., & Gosain, A. (2011). DWEVOLVE: A Requirement based framework for data warehouse evolution. *SIGSOFT Softw. Eng. Notes*, 36(6), 1-8.
- Thiele, M., & Lehner, W. (2010). Evaluation of Load Scheduling Strategies for Real-Time Data Warehouse Environments. In M. Castellanos, U. Dayal & R. J. Miller (Eds.), *Enabling Real-Time Business Intelligence* (Vol. 41, pp. 84-99): Springer Berlin Heidelberg.
- Turban, E., Rainer, R. K., & Potter, R. E. (2005). *Introduction to Information Technology* (3rd ed.). New Jersey: John Wiley & Sons Inc.,.
- Turban, E., Sharda, R., & Delen, D. (2011). *Decision Support and Business Intelligence Systems* (Ninth Edition ed.). New Jersey, USA: Pearson Education, Inc.
- Ullman, J. D. (1987). *Database Theory: Past and Future*. Paper presented at the ACM SIGACT-SIGMOD-SIGART symposium on Principles of database systems, San Diego, California, United States.
- Vaishnavi, V. K., & Kuechler, W. (2004, 4 August, 2007). Design Research in Information Systems Retrieved 10 October, 2007, from <http://www.isworld.org/Researchdesign/drisISworld.htm>
- Vaishnavi, V. K., & Kuechler, W. (2008). *Design Science Research Methods and Patterns: Innovating Information and Communication Technology*: Auerbach Publications, Taylor & Francis Group.
- Vassiliadis, P., Bouzeghoub, M., & Quix, C. (2000). Towards quality-oriented data warehouse usage and evolution. *Information System*, 25(2), 89-115.
- Wand, Y., & Wand, R. Y. (1996). Anchoring data quality dimensions in ontological foundations. *Communications of the ACM*, 39(11), 86-95.
- Wang, J., Martin, N., & Poulouvassilis, A. (2012). An Ontology-Based Quality Framework for Data Integration. In L. Niedrite, R. Strazdina & B. Wangler (Eds.), *Workshops on Business Informatics Research* (Vol. 106, pp. 196-208): Springer Berlin Heidelberg.
- Wang, R. Y., & Strong, D. M. (1996). Beyond Accuracy: What Data Quality Means to Data Consumers. *Journal of Management Information Systems*, 12(4), 5-34.
- Watson, H., & Harley, B. (1997). Data Warehousing: A framework and survey of current practice. *Journal of Data Warehousing*, 2(1), 10-17.
- Watson, R. T. (2004). *Database Management: An Organizational Perspective* (4th ed.): John Wiley & Sons, Inc.
- Westerman, P. (2001). *Data Warehousing: Using the Wal-Mart Model*: Morgan Kaufman.
- White, C. (2005, May 2005). The Generation of Business Intelligence: Operational BI. *Information Management Magazine*, May 2005.
- White, C. (2007). Who needs real-time business intelligence? *Teradata Magazine*, September 2007, 1-2.
- Whitten, J. L., Bentley, L. D., & Dittman, K. C. (2003). *System Analysis and Design Method* (6th ed.). USA: McGraw-Hill.
- Widom, J. (1995). *Research Problems in Data Warehousing*. Paper presented at the CIKM '95, Baltimore MD USA.
- Williams, S., & Williams, N. (2003). The Business Value of Business Intelligence. *Business Intelligence Journal*(Fall 2003), 1-11.
- Winsemann, T., Köppen, V., & Saake, G. (2012). A Layered Architecture for Enterprise Data Warehouse Systems. In M. Bajec & J. Eder (Eds.), *Advanced Information Systems Engineering Workshops* (Vol. 112, pp. 192-199): Springer Berlin Heidelberg.

- Winter, R., & Strauch, B. (2003). *A Method for Demand-driven Information Requirements Analysis in Data Warehousing Projects*. Paper presented at the 36th Hawaii International Conference on Systems Sciences.
- Winter, R., & Strauch, B. (2004). *Information Requirements Engineering for Data Warehouse Systems*. Paper presented at the 2004 ACM Symposium on Applied Computing, Nicosia, Cyprus.
- Wu, J. (2000). What is Business Intelligence? Retrieved 21 May, 2007, from http://www.dmreview.com/article_sub.cfm?articleId=1924
- Yin, R. K. (2009). *Case Study Research: Design and Methods* (4th ed.). California: Sage Publications, Inc.
- Yu, E., & Cysneiros, L. M. (2002). *Agent-Oriented Methodologies – Towards A Challenge Exemplar*. Paper presented at the 4th Intl. Bi-Conference Workshop on Agent-Oriented Information Systems (AOIS), Toronto, Canada.
- Ziegler, P., & Dittrich, K. R. (2004, 22-27 August 2004). *Three decades of data Integration - All problems solved?* Paper presented at the In 18th IFIP World Computer Congress (WCC 2004), Toulouse, France.
- Zielczynski, P. (2008). *Requirement Management Using IBM Rational Requisite Pro*. U.S.A: IBM Corporation.
- Zmud, R. (1997). Editor's Comments. *MIS Quarterly* (21:2), June 1997, 21(2), xxi-xxii.